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(54) **IMPLANTABLE MEDICAL DEVICE AND METHOD OF CONTROLLING THE SAME**

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(57) **ABSTRACT**

An implantable medical device (IMD) is provided. The IMD includes a medical procedure performing unit configured to perform a medical procedure inside a body of a user, a code generating unit configured to detect a motion state of the user, and to generate a motion code that represents a user's intention based on the detected motion state, and a control unit configured to control the medical procedure of the medical procedure performing unit based on the generated motion code.

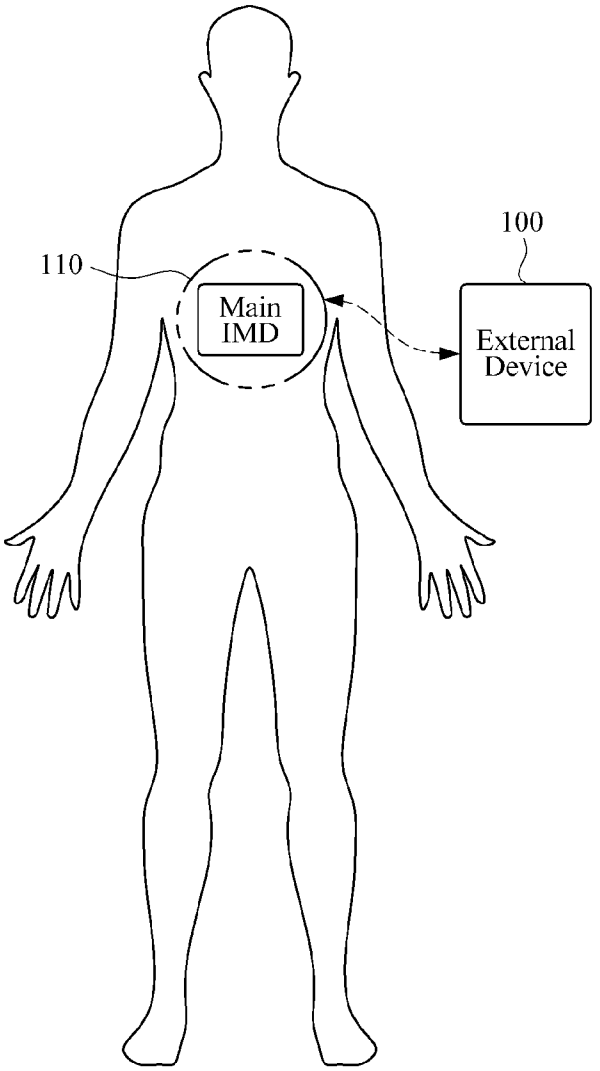


FIG. 1

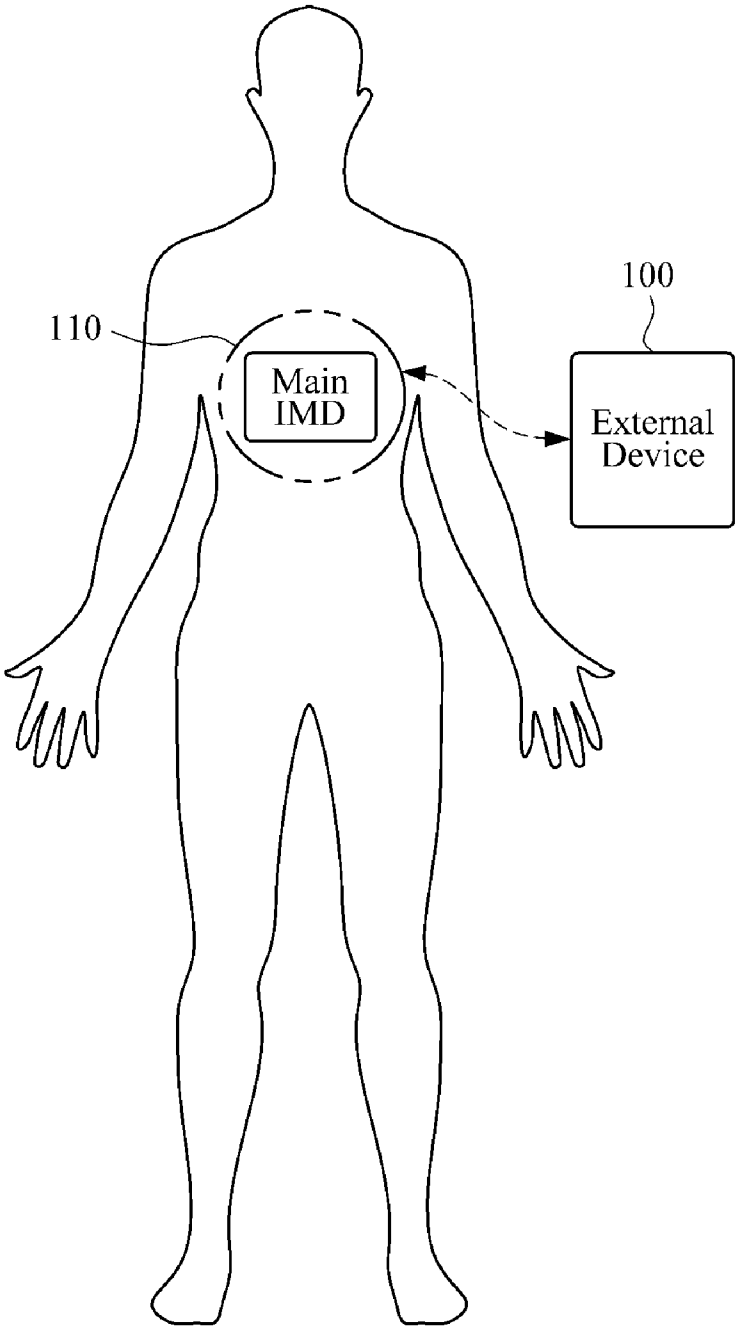


FIG. 2

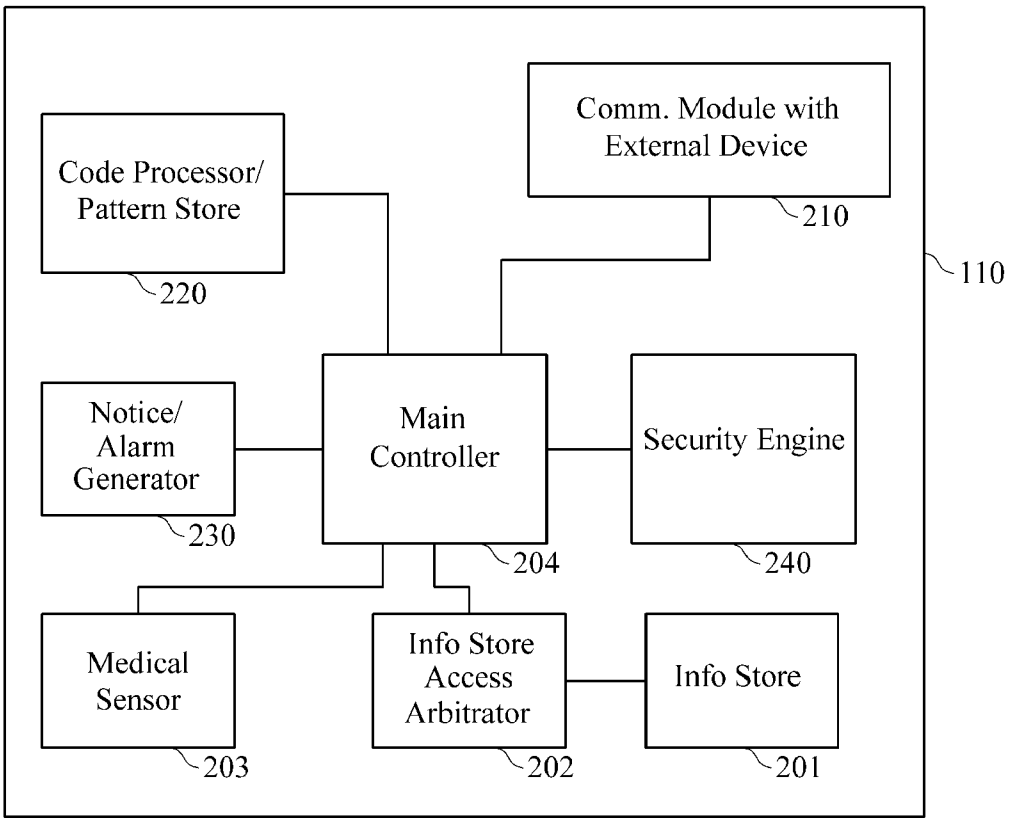

Comm. Module with External Device
210
Code Processor/ Pattern Store
220
110
Notice/ Alarm Generator
230
Main Controller
204
Security Engine
240
Medical Sensor
203
Info Store Access Arbitrator
202
Info Store
201

FIG. 3

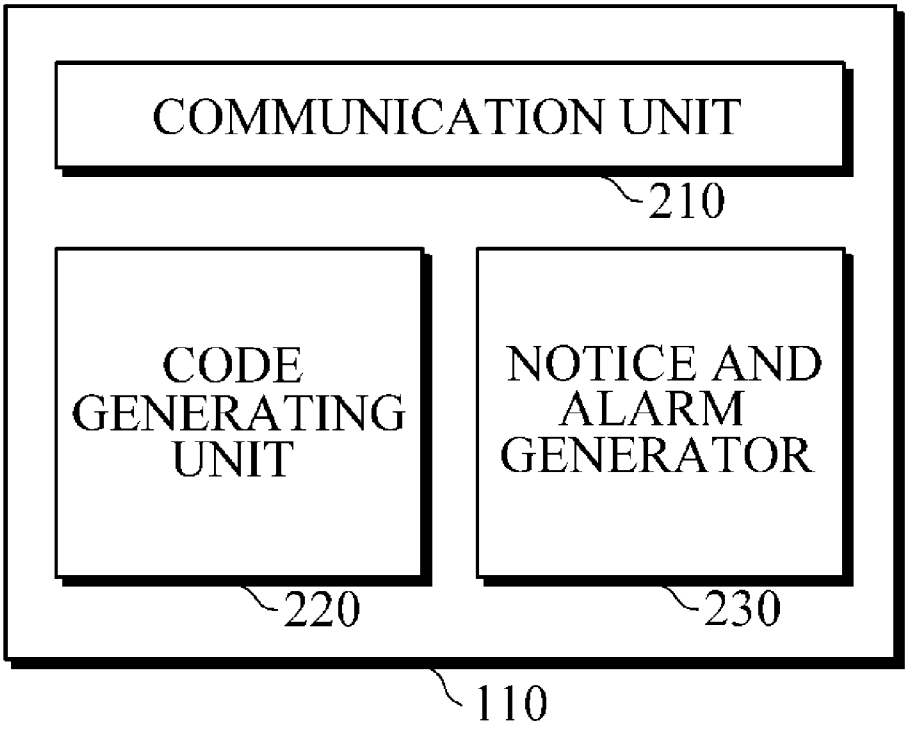

COMMUNICATION UNIT
210
CODE GENERATING UNIT
220
NOTICE AND ALARM GENERATOR
230
110

FIG. 4

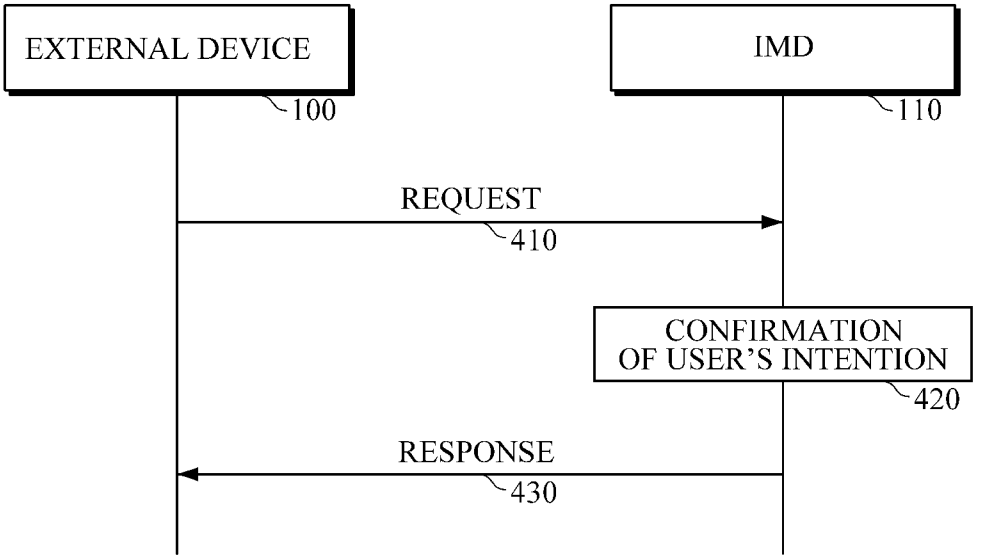

EXTERNAL DEVICE
100
IMD
110
REQUEST
410
CONFIRMATION
OF USER'S INTENTION
420
RESPONSE
430

FIG. 5

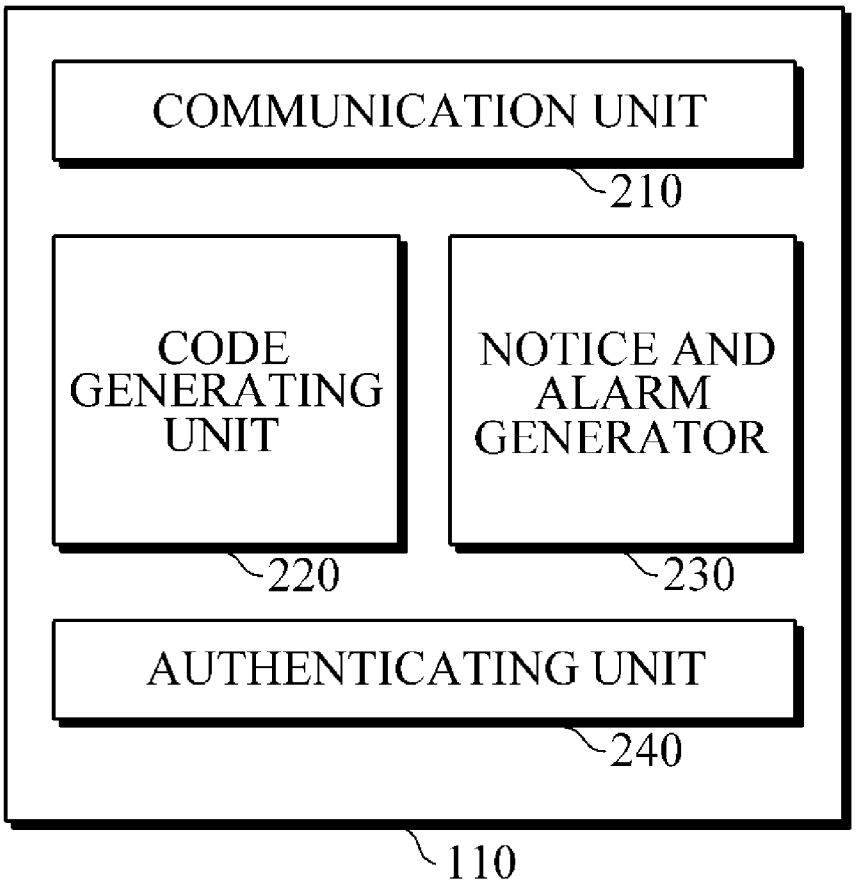

COMMUNICATION UNIT
210
CODE GENERATING UNIT
220
NOTICE AND ALARM GENERATOR
230
AUTHENTICATING UNIT
240
110

FIG. 6

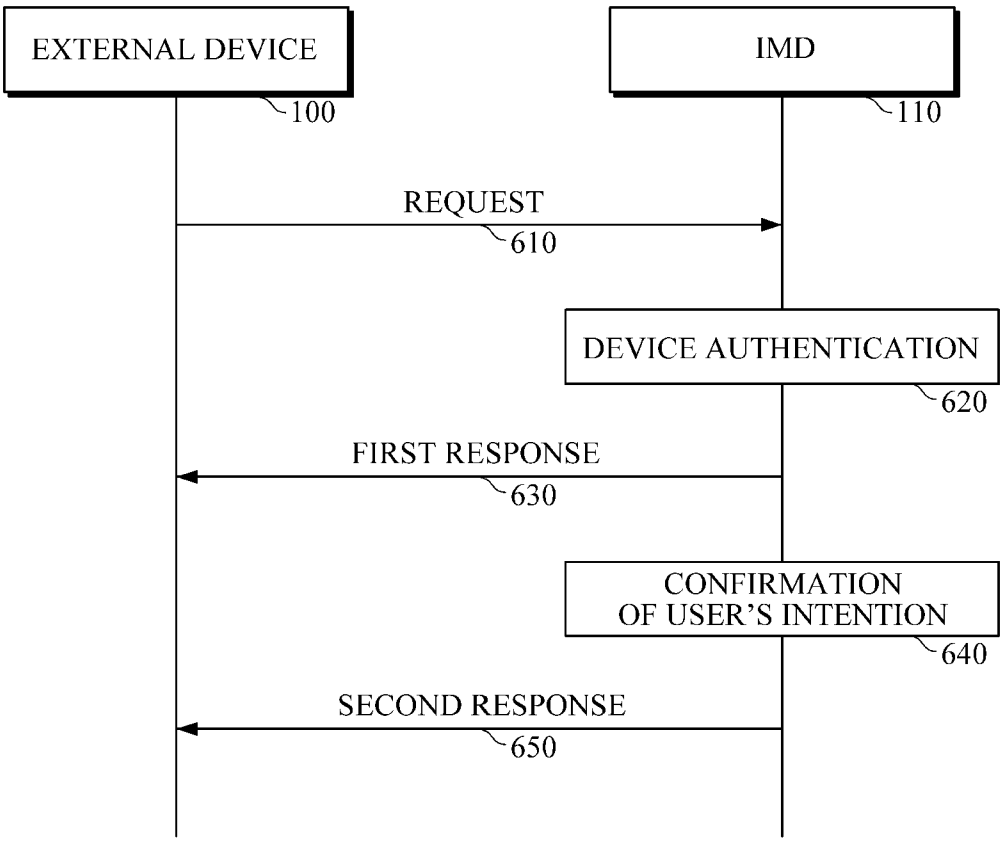

EXTERNAL DEVICE
100
IMD
110
REQUEST
610
DEVICE AUTHENTICATION
620
FIRST RESPONSE
630
CONFIRMATION OF USER'S INTENTION
640
SECOND RESPONSE
650

FIG. 7

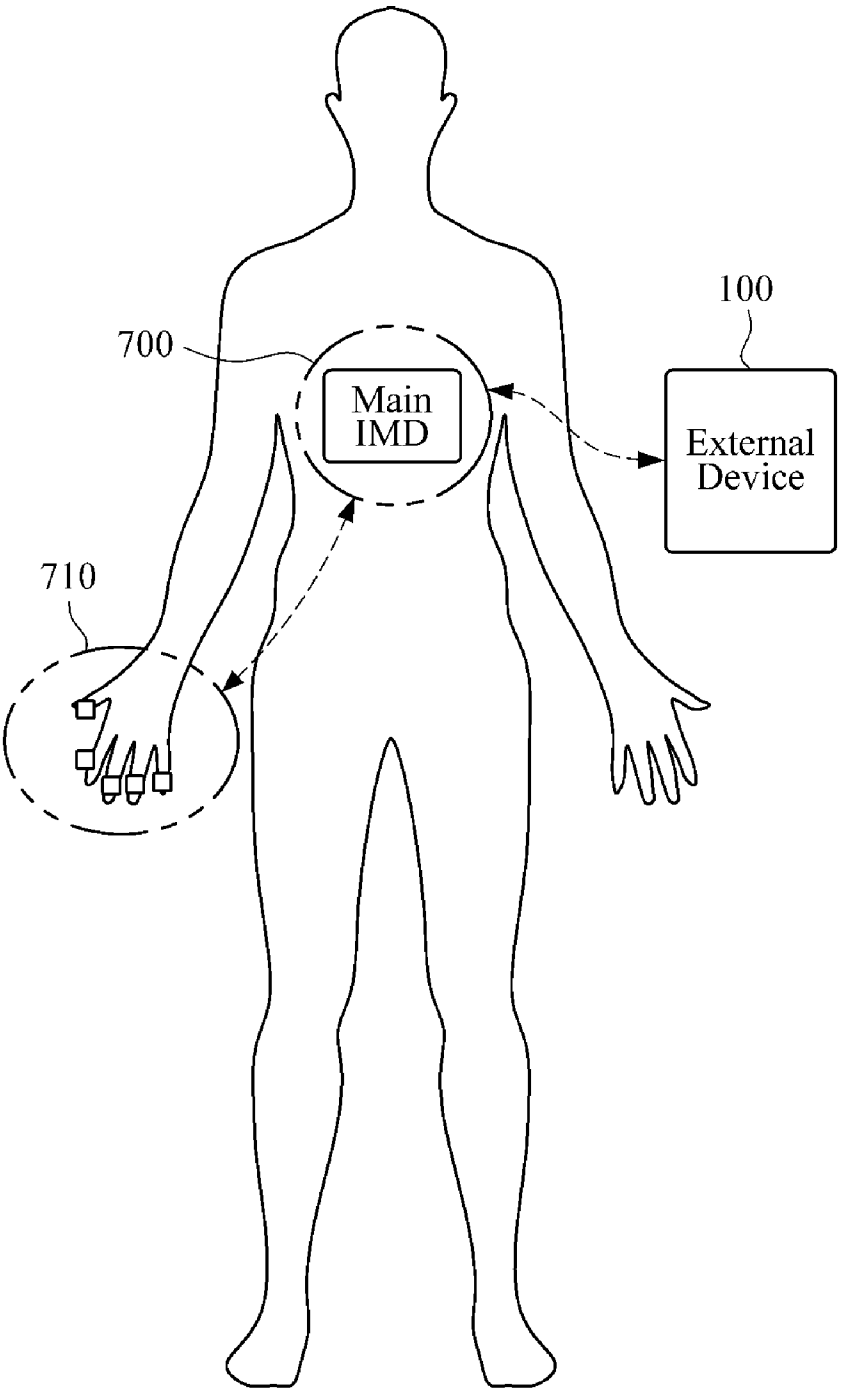


FIG. 8A

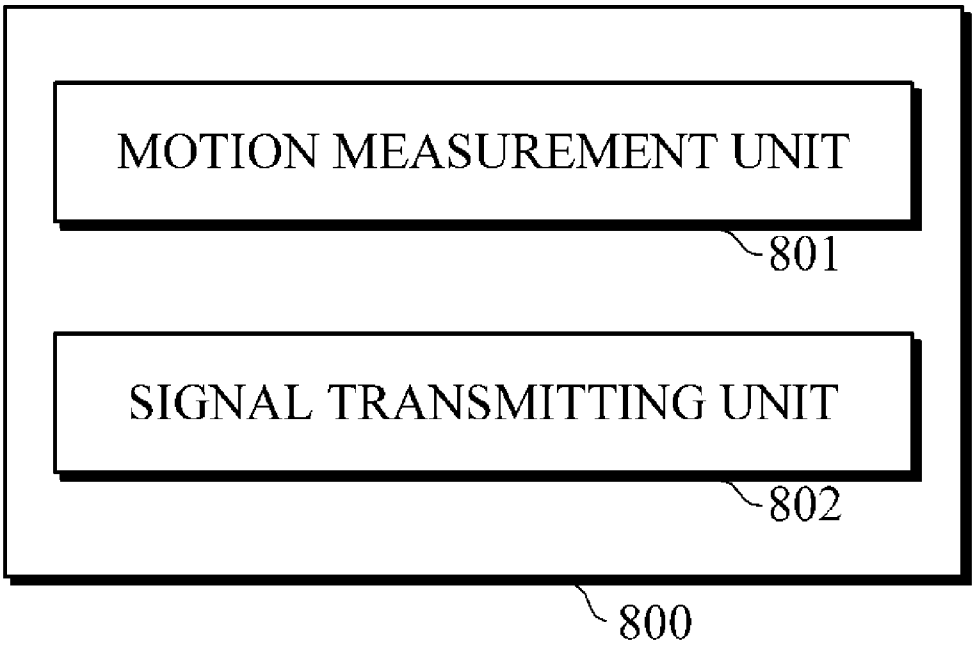

MOTION MEASUREMENT UNIT
801
SIGNAL TRANSMITTING UNIT
802
800

FIG. 8B

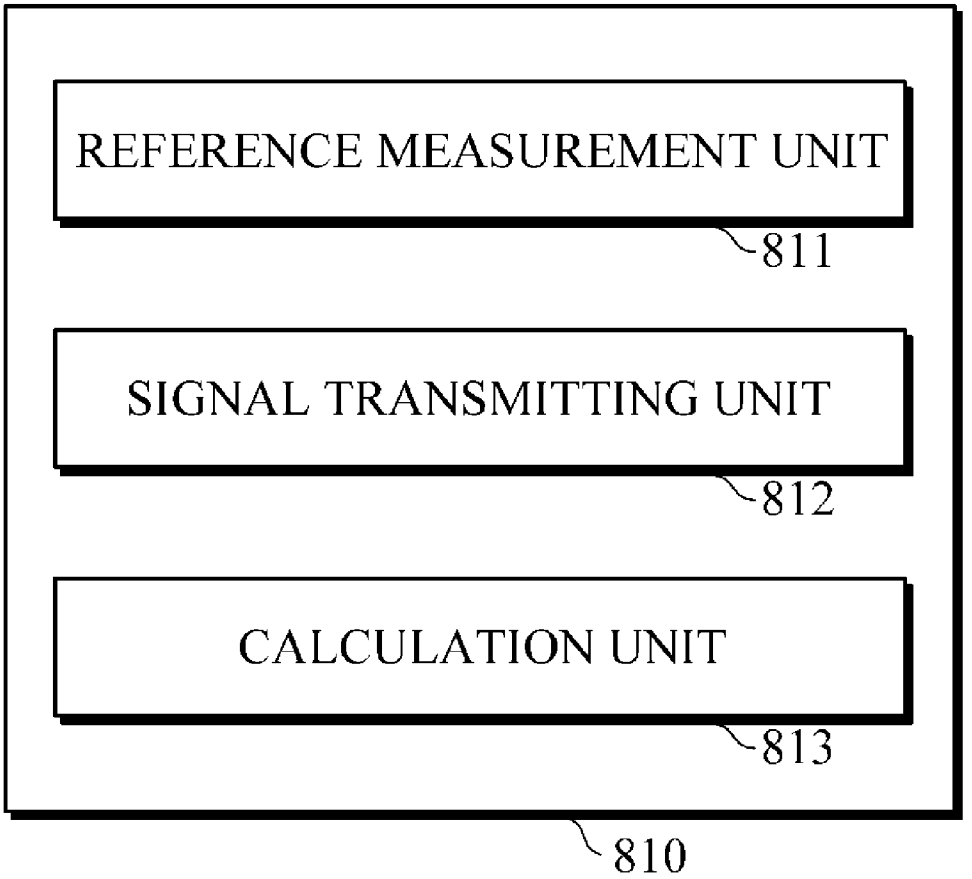
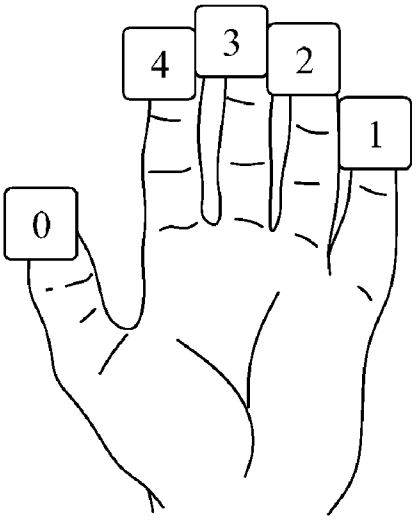

REFERENCE MEASUREMENT UNIT
811
SIGNAL TRANSMITTING UNIT
812
CALCULATION UNIT
813
810

FIG. 9A



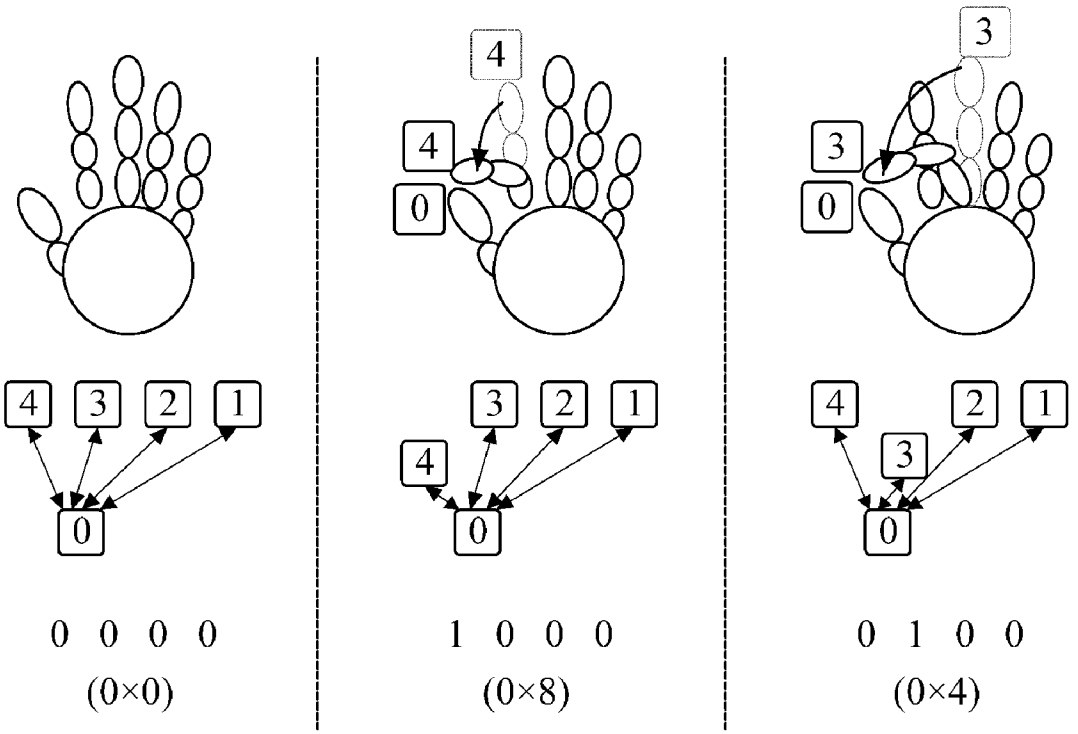


FIG. 9B

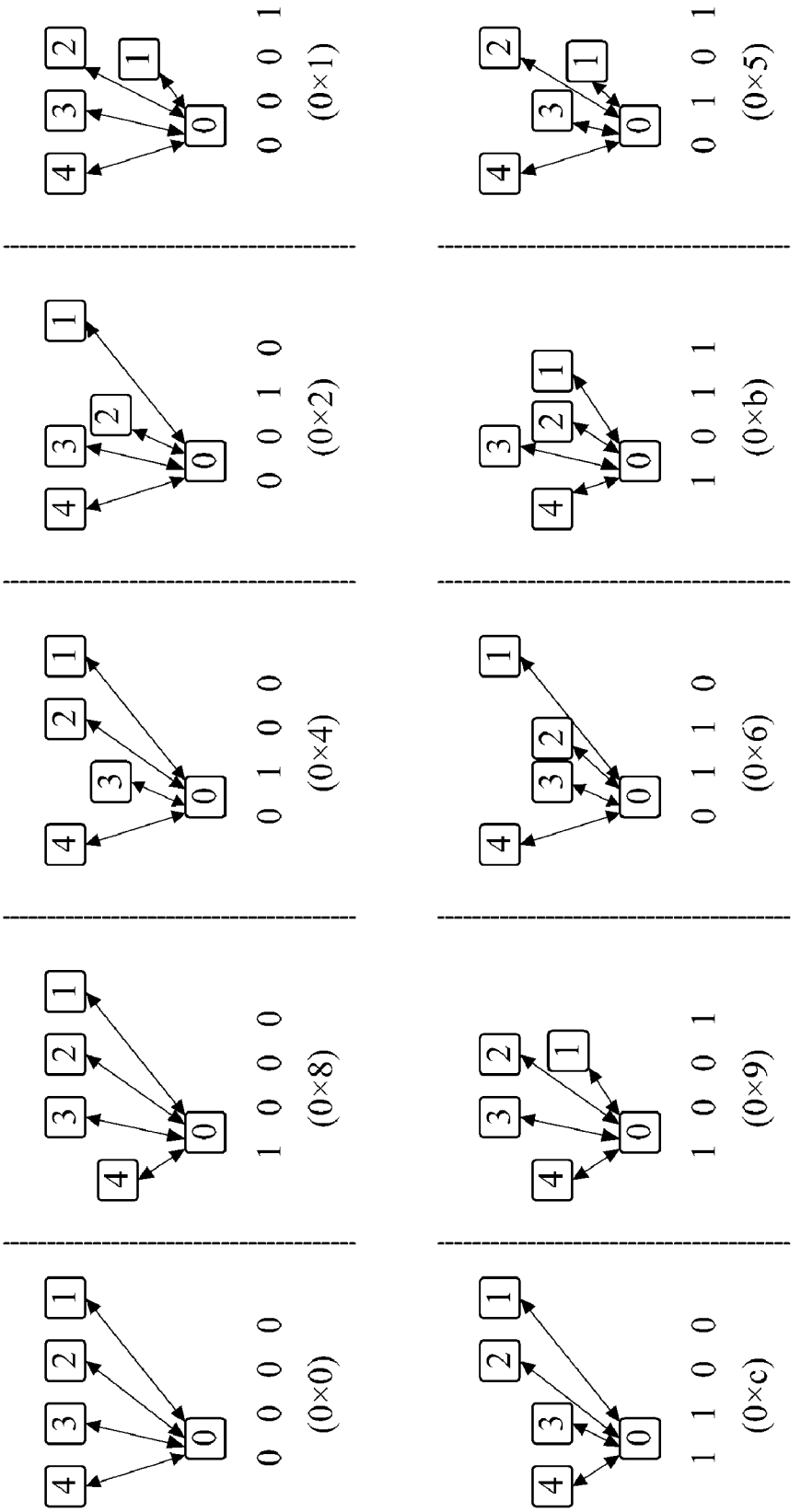

0 0 0 0 0
(0×0)
0 0 0 0 1
(0×1)
0 0 0 1 0
(0×2)
1 0 0 0 0
(0×8)
0 1 0 0 0
(0×4)
1 0 0 0 1
(0×9)
0 1 0 0 1
(0×5)
1 1 0 0 0
(0×c)
0 1 1 1 0
(0×6)
1 0 1 1 1
(0×b)

FIG. 10

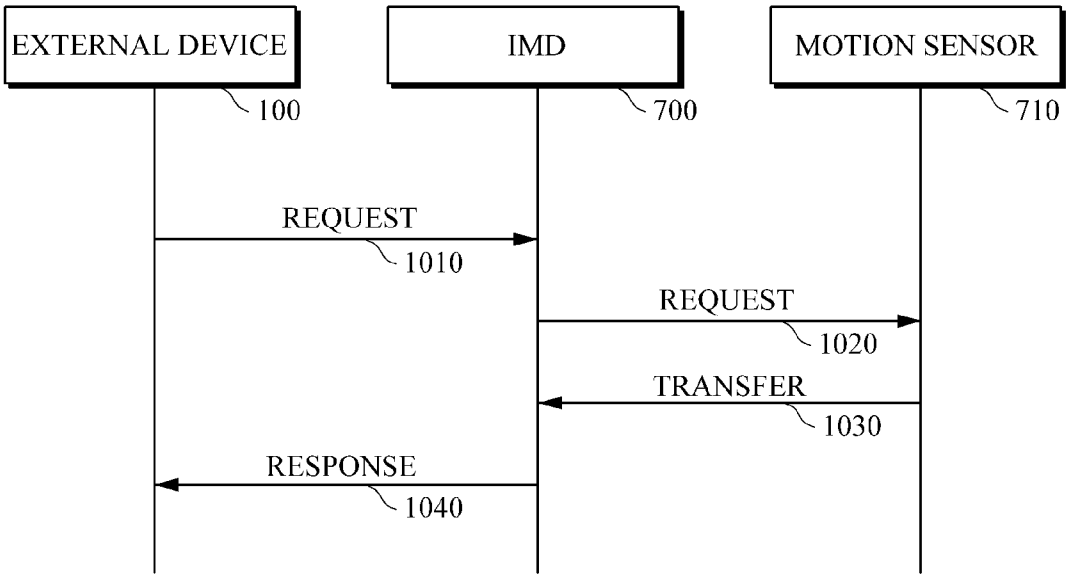

EXTERNAL DEVICE
100
IMD
700
MOTION SENSOR
710
REQUEST
1010
REQUEST
1020
TRANSFER
1030
RESPONSE
1040

FIG. 11

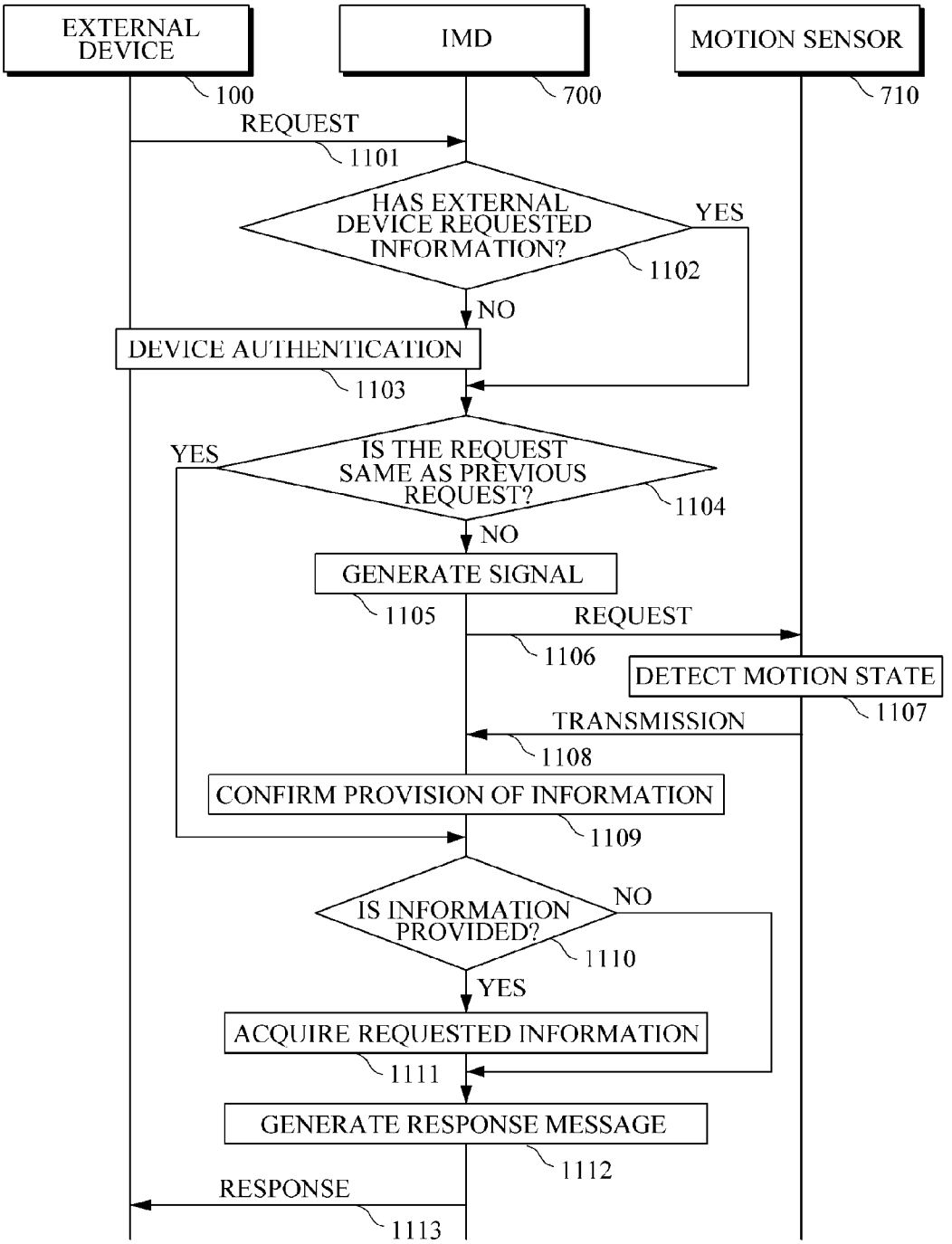

EXTERNAL DEVICE
100
IMD
700
MOTION SENSOR
710
REQUEST
1101
HAS EXTERNAL DEVICE REQUESTED INFORMATION?
1102
YES
NO
DEVICE AUTHENTICATION
1103
YES
IS THE REQUEST SAME AS PREVIOUS REQUEST?
1104
NO
GENERATE SIGNAL
1105
REQUEST
1106
DETECT MOTION STATE
1107
TRANSMISSION
1108
CONFIRM PROVISION OF INFORMATION
1109
IS INFORMATION PROVIDED?
1110
NO
YES
ACQUIRE REQUESTED INFORMATION
1111
GENERATE RESPONSE MESSAGE
1112
RESPONSE
1113

FIG. 12

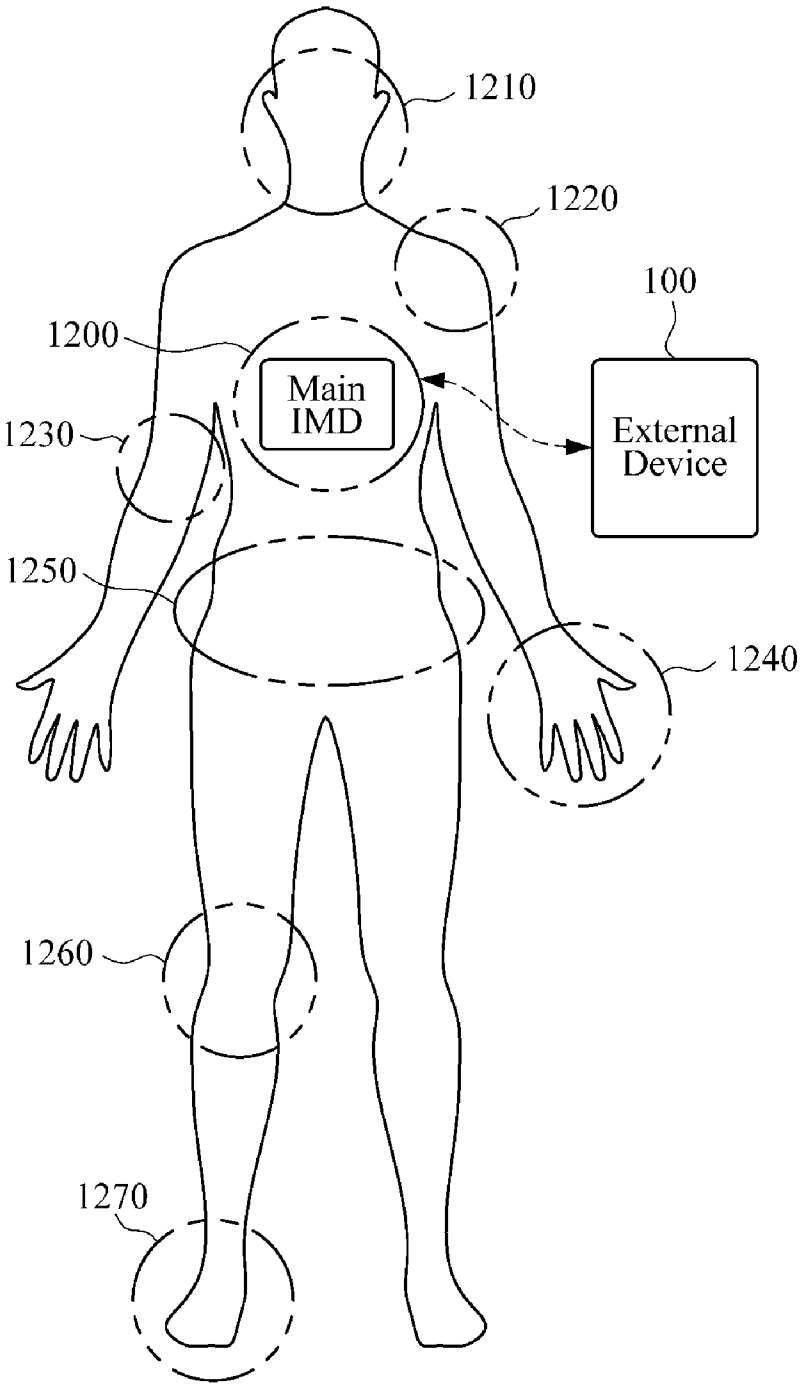

1210
1220
100
1200
Main IMD
External Device
1230
1250
1240
1260
1270

FIG. 13

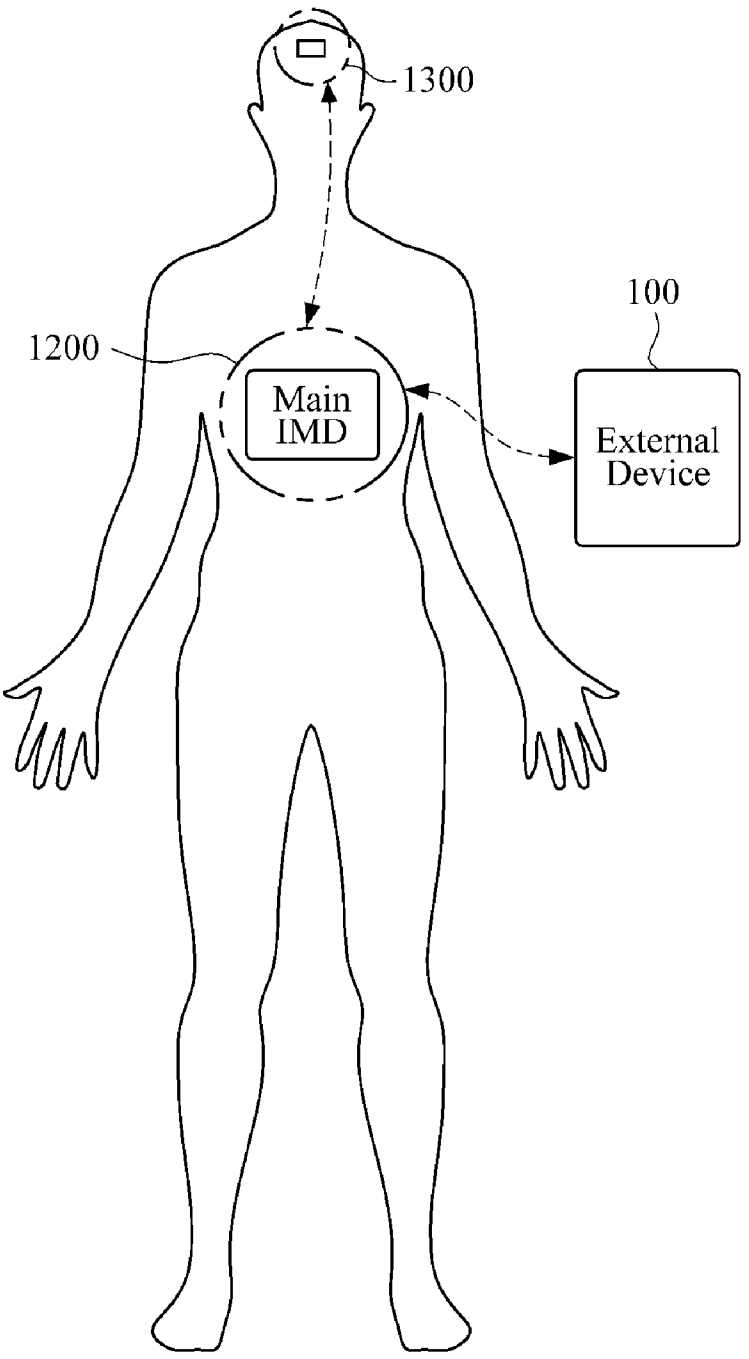
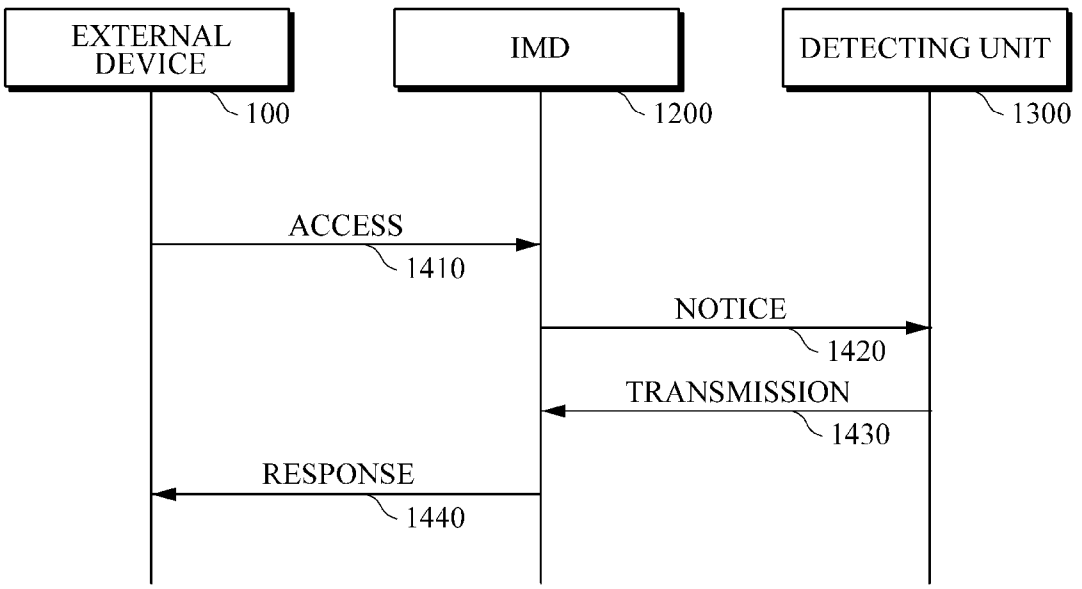


FIG. 14


EXTERNAL DEVICE
100
IMD
1200
DETECTING UNIT
1300
ACCESS
1410
NOTICE
1420
TRANSMISSION
1430
RESPONSE
1440

IMPLANTABLE MEDICAL DEVICE AND METHOD OF CONTROLLING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application claims the benefit under 35 U.S.C. §119(a) of Korean Patent Application Nos. 10-2010-0097955, filed on Oct. 7, 2010, and 10-2011-0004263, filed on Jan. 14, 2011, in the Korean Intellectual Property Office, the entire disclosures of which are incorporated herein by reference for all purposes.

BACKGROUND

[0002] 1. Field

[0003] The following description relates to an implantable medical device (IMD) and method of controlling the same.

[0004] 2. Description of the Related Art

[0005] An implantable medical device (IMD) may be implanted into a human body and may operate for a medical purpose.

[0006] IMD may monitor a state of primary organs such as the heart and may control the organs to function normally.

[0007] In addition, the IMD may provide physiological/pathological state information which may be required for medical practice in, for example, a consulting room, an emergency room, and heath care center.

[0008] However, it may be difficult to control or change operation of the IMD because the IMD is implanted in a human body.

[0009] Moreover, since the physiological/pathological state information of a patient, which may be provided by the IMD, is substantially private, the provision of such state information to an improper device may result in violating the privacy of the patient.

SUMMARY

[0010] The following description relates to an implantable medical device (IMD) which may be controlled based on a user's intention, and a method of controlling the IMD.

[0011] In addition, an IMD is provided that controls access by an external device based on a user's intention and a method of controlling the access.

[0012] In one general aspect, an implantable medical device (IMD) is provided. The IMD includes a medical procedure performing unit configured to perform a medical procedure inside a body of a user, a code generating unit configured to detect a motion state of the user, and to generate a motion code that represents a user's intention based on the detected motion state, and a control unit configured to control the medical procedure of the medical procedure performing is unit based on the generated motion code.

[0013] The medical procedure performing unit may collect physiological/pathological state information of the user.

[0014] The control unit may determine whether to transmit the physiological/pathological state information to an external device based on the motion code.

[0015] The code generating unit may detect the motion state that includes a standstill state of the user, a moving state of the user, a moving state of user's pupils, a brainwave state of the user, or a combination thereof.

[0016] The code generating unit may include a first sensor configured to set a reference for the motion state of the user, and a second sensor configured to detect the motion state which includes the standstill state of the user, a moving state of the user, a moving state of the user's pupils, or a combination thereof.

[0017] The first sensor or the second sensor may be placed outside of the user's body to detect a motion state of the user.

[0018] The code generating unit may comprise a sensor configured to be worn on or implanted in a user's finger to detect the motion state of the user.

[0019] The IMD may further include an authenticating unit configured to authenticate whether the external device which communicates with the IMD is authorized to acquire the physiological/pathological state information of the user.

[0020] The code generating unit generates the motion code in response to the authenticating unit authenticating the external device to be authorized to acquire the physiological/pathological state information.

[0021] The IMD may further include a notice and alarm generator configured to generate a signal to notify of an access of the external device in response to the external device attempting is to access the IMD to communicate therewith.

[0022] The notice and alarm generator may generate a recognizable signal in the form of light, sound, vibration, stimulus, or a combination thereof.

[0023] The user's intention may include allowing the performance of the medical procedure or restricting the performance of the medical procedure.

[0024] In another general aspect, an implantable medical device (IMD) is provided. The IMD includes an information collecting unit configured to collect physiological/pathological state information of a user, and a provision determining unit configured to detect a motion state of the user, and to determine whether to provide the physiological/pathological state information to an external device according to a user's intention identified based on the detected motion state.

[0025] The provision determining unit may include a communication module configured to transmit the physiological/pathological state information to the external device, a detecting unit configured to detect a motion state which includes a standstill state of the user, a moving state of the user, a moving state of user's pupils, a brainwave state of the user or a combination thereof, a code generating unit configured to generate a motion code that represents the user's intention for the providing of the physiological/pathological state information based on the detected motion state, and a control unit configured to control the communication module based on the generated motion code.

[0026] The IMD may further include a notice and alarm generator configured to generate a signal to notify of an access of the external device in response to the external device attempting to access the IMD to acquire the physiological/pathological state information.

[0027] The IMD may further include an authenticating unit configured to authenticate whether the external device that communicates with the IMD is authorized to acquire the physiological/pathological state information.

[0028] The authenticating unit may authenticate the external device by determining whether the external device has previously accessed or whether physiological/pathological state information to be transmitted is the same as the physiological/pathological state information requested by the external device.

[0029] The provision determining unit may detect the motion state of the user in response to the external device being authorized to acquire the physiological/pathological state information.

[0030] The code generating unit may compare the motion state of the user with a previously stored motion state of the user and may generate a motion code corresponding to the detected motion state.

[0031] In another general aspect, a method of controlling an implantable medical device (IMD) with respect to an access of an external device is provided. The method includes receiving a request for state information of the IMD or physiological/pathological state information of a user from the external device, identifying a user's intention by detecting a motion state of the user, and determining whether to transmit the requested state information to the external device according to the identified user's intention.

[0032] The identifying of the user's intention may include detecting the motion state of the user which includes a stand-still state of the user, a moving state of the user, a moving state of user's pupils, a brainwave state of the user, or a combination thereof.

[0033] The identifying of the user's intention may include generating a motion code that represents a user's intention based on the detected motion state of the user, and identifying the user's intention that corresponds to the generated motion code by comparing the generated motion code with a previously stored motion code.

[0034] The determining whether to transmit the requested state information comprises is providing the state information to the external device or transmitting a refusal response to the external device according to the identified user's intention.

[0035] In yet another general aspect, an external device for communicating with an implantable medical device (IMD) is provided. The external device includes a communications unit configured to access state information stored in the IMD, and a reception unit configured to receive the state information determined by a motion state of the user corresponding to a user's intention detected by the IMD.

[0036] The user's intention may include allowing the transmission of the state information or restricting the transmission of the state information.

[0037] Other features and aspects may be apparent from the following detailed description, the drawings, and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] FIG. **1** is a diagram illustrating an example embodiment showing a concept of controlling an implantable medical device based on user's intention.

[0039] FIG. **2** is a diagram illustrating an example embodiment of an implantable medical device (IMD).

[0040] FIG. **3** is a diagram illustrating another example embodiment of the IMD.

[0041] FIG. **4** is a flowchart illustrating an example embodiment of a method of controlling an implantable medical device (IMD) when an external device accesses to the IMD.

[0042] FIG. **5** is a diagram illustrating another example embodiment of the IMD.

[0043] FIG. **6** is a flowchart illustrating another example embodiment of a method of controlling the IMD when an external device accesses the IMD.

[0044] FIG. **7** is a diagram illustrating an example embodiment of an IMD implanted in a human body.

[0045] FIGS. **8**A and **8**B are diagrams illustrating example embodiments of a motion sensor of an IMD.

[0046] FIGS. **9**A and **9**B are diagrams illustrating example embodiments for explaining motion codes generated by a plurality of motion sensors of an IMD.

[0047] FIG. **10** is a flowchart illustrating an example embodiment of a method of controlling an IMD having a motion sensor.

[0048] FIG. **11** is a flowchart illustrating an example embodiment of a method of controlling the IMD having a motion sensor.

[0049] FIG. **12** is a diagram illustrating an example embodiment showing body parts of a user that allows the recognition of a user's intention through a motion state of the user.

[0050] FIG. **13** is a diagram illustrating an example embodiment of a structure for controlling an IMD by recognizing a user's intention through the direct detection of the brain activity.

[0051] FIG. **14** is a flowchart illustrating an example embodiment of a method of controlling an implantable medical device (IMD) by recognizing a user's intention based on direct detection of brain activity.

[0052] Throughout the drawings and the detailed description, unless otherwise described, the same drawing reference numerals will be understood to refer to the same elements, features, and structures. The relative size and depiction of these elements may be exaggerated for clarity, illustration, and convenience.

DETAILED DESCRIPTION

[0053] The following description is provided to assist the reader in gaining a comprehensive is understanding of the methods, apparatuses, and/or systems described herein. Accordingly, various changes, modifications, and equivalents of the methods, apparatuses, and/or systems described herein will be suggested to those of ordinary skill in the art. Also, descriptions of well-known functions and constructions may be omitted for increased clarity and conciseness.

[0054] FIG. **1** illustrates a concept of controlling an implantable medical device based on a user's intention.

[0055] Referring to FIG. **1**, a user may directly control a main implantable medical device (IMD) **110** to perform a variety of operations. For example, the user may directly control the main IMD **110** when an external device **100** makes an access to the main IMD **110** to access state information of the IMD **110**, physiological/pathological state information of the user, or other information collected by the IMD **110**.

[0056] The main IMD **110**, which is to be implanted in a body of the user, may collect physiological/pathological information of the user, and may perform a medical procedure to control the operation of an organ while maintaining a close connection with the organ. These are illustrative functions to be provided by an IMD.

[0057] The main IMD **110** may be configured as shown in an example embodiment illustrated in FIG. **2**.

[0058] FIG. **2** illustrates an example embodiment of an implantable medical device (IMD).

[0059] An information store (represented as "Info Store" in FIG. **2**) **201** may store state information of the IMD **110**, physiological/pathological state information of a user, and other information collected by the IMD **110**.

[0060] An information store access arbitrator (represented as "Info Store Access Arbitrator" in FIG. **2**) **202** may arbitrate

attempts to access the information store **201**, and log details of all is notable accesses of the information store **201**.

[0061] A medical sensor **203** may collect the physiological/pathological state information of the user, and may, if necessary, perform a medical procedure to control the organ.

[0062] A main controller **204** may arbitrate and control functional modules included in the IMD **110**.

[0063] The above described configuration **201** to **204** may perform basic functions as the IMD may have.

[0064] The above configuration, as elements of the IMD, may be represented as below.

[0065] A medical procedure performing unit (not shown) may perform a medical procedure inside the body of the user, and may include the medical sensor **203**.

[0066] A control unit may control the medical procedure of the medical procedure performing unit, and may perform some functions of the main controller **204**.

[0067] An information collecting unit may collect the physiological/pathological state information of the user, and may perform some functions of the medical sensor **204**.

[0068] A provision determining unit (not shown) may detect a motion state of the user, and may determine whether to transmit the physiological/pathological state information of the user to an external device based on user's desire based on the detected motion state. The provision determining unit may perform some functions of the main controller **204**.

[0069] In addition, the IMD **110** may further include a communication module (represented as "Comm Module" in FIG. **2**) **210**, a code generating unit (hereinafter, it will be referred to as a "code processor/pattern store") **220**, a notice and alarm generator **230**, and an authenticating unit (hereinafter, it will be referred to as a "security engine") **240**.

[0070] Each element will be described.

[0071] FIG. **3** illustrates another example embodiment of the IMD. Referring to the example is embodiment illustrated in FIG. **3**, the IMD **110** may include a communication module **210**, a code processor/pattern store **220**, and notice and alarm generator **230**.

[0072] The IMD **110**, which may be implanted in a human body to collect physiological/pathological state information of a user, to perform a medical procedure to normalize biological activities in the user's body and to communicate with the external device **100** (see FIG. **1**), may include the communication module **210** for the communication with the external device **100**.

[0073] Referring to the example embodiment illustrated in FIG. **1**, the external device **100** 1) may be connected with the communication module **210** to acquire state information of the IMD **110**, 2) may access the IMD **110** to acquire the stored physiological/pathological state information of the user or 3) other information collected by the IMD **110**.

[0074] The code processor/pattern store **220** may generate a motion code to control the operations including collection of the physiological/pathological state information of the user or the medical procedure to normalize the biological activities in the body. The motion code may be generated based on a detected motion state of the user who is implanted with the IMD **110**.

[0075] Here, the detected motion state of the user may include almost all movements (such as gestures and motions) which involve changes in user's body. The movements include, for example, standstill or moving of the body, and moving of the pupils. The detected motion state may include any data, for example, brainwaves, which are useful to infer an intention or thinking of the user.

[0076] The notice and alarm generator **230** may generate a signal to be transmitted to the user to notify that the IMD **110** is in a state capable of detecting the user's motion state. In other words, the notice and alarm generator **230** may generate a signal to notify the user of an event that the is external device **100** attempts access to the IMD **110**. In this case, the signal may be in any form including light, sound, vibration, and any kind of stimulus, that the user may recognize. In addition, the signal may be implemented as, for example, a clock, a terminal, or an element of an external device, so the user can recognize the signal.

[0077] Thus, the communication module **210** may communicate with the external device **100** to be provided with the state information and the user's physiological/pathological state information from the IMD **110**. The notice and alarm generator **230** may generate a signal to notify the user of an access of the external device **100** in response to the IMD **110** receiving a request for the state information from the external device **100**.

[0078] The user may recognize the access of the external device **100** based on the signal generated by the notice and alarm generator **230**, and the code processor/pattern store **220** may detect the motion state of the user, may generate the motion code for identifying a user's intention, and may, if necessary, store the generated motion code. The IMD **110** may perform a specific operation including the providing of state information to the external device **100** and the conducting of a medical procedure inside the user's body based on the motion code.

[0079] FIG. **4** illustrates a flowchart of an example embodiment of a method of controlling an implantable medical device (IMD) when an external device accesses to the IMD.

[0080] The method shown in the example embodiment illustrated in FIG. **4** may be implemented between the external device **100** and the IMD **110** based on their basic configurations.

[0081] First, the external device **100** may request the IMD **110**, which may retain state information of itself or physiological/pathological state information of a user, to provide such information (**410**) to the external device.

[0082] In response to the request, the IMD **110** may confirm with the user whether to provide the is requested information to the external device **100** (**420**). In response to the user making a movement to allow the IMD **110** to recognize user's intention, the IMD **110** may identify the user's intention.

[0083] The code processor/pattern store **220** may detect the motion state of the user which includes a standstill state and a moving state of the user and a moving state of user's pupils, and may generate the motion code based on the motion state. The user's intention may be inferred by comparing the generated motion code and a motion code previously stored in the IMD **110**.

[0084] The user's intention may involve approving or rejecting the providing of information, and executing operations of the IMD **110**, for example, controlling the medical procedure performed by the IMD **110**. In addition, the user's intention may be stored or updated as a motion code in the IMD **110**.

[0085] Then, the IMD **110** may provide state information requested by the external device **100** or transmit a rejection message to the external device **100** based on the user's intention which has been confirmed at **420** (**430**).

[0086] FIG. **5** illustrates another example embodiment of the IMD. Referring to the example embodiment illustrated in FIG. **5**, the IMD **110** may further include the security engine **240** in addition to the communication module **210**, the code processor/pattern store **220**, and the notice and alarm generator **230** which are shown in the example embodiment illustrated in FIG. **3**.

[0087] The operations of the communication module **210**, the code processor/pattern store **220**, and the notice and alarm generator **230** may be the same as those shown in the example embodiment illustrated in FIG. **3**.

[0088] The IMD **110** may communicate with the external device **100** through the communication module **210**, and the security engine **240** may verify whether the external device **100** is authorized to acquire state information when the external device **100** accessesthe IMD to request state information of the IMD **110** or physiological/pathological state information of the user.

[0089] A variety of methods may be utilized to verify the external device. For example, an identification stored in the external device may be matched with an identification stored in the IMD. Once the external device **100** has been verified, the notice and alarm generator **230** may generate a signal to notify the user of an event that the external device **100** accesses the IMD **110** and the user may make a specific movement in order to generate a motion code to allow the IMD to recognize user's intention.

[0090] The code processor/pattern store **220** may detect the movement and generate the motion code. The IMD **110** may determine whether to perform a specific activity based on the generated motion code, and may provide the information requested by the external device **100** or control other operation.

[0091] FIG. **6** illustrates a flowchart of another example embodiment of a method of controlling the IMD in response to an external device accessing the IMD.

[0092] The method shown in the example embodiment illustrated in FIG. **6** is implemented between the external device **100** and the IMD **110** based on their basic configurations.

[0093] First, the external device **100** accesses and requests the IMD **110**, which may store state information of itself or physiological/pathological state information of a user, to provide such information (**610**).

[0094] Then, in response to the request, the IMD **110** may perform device authentication on the accessed external device **100** (**620**).

[0095] Once the device authentication has been completed between the IMD **110** and the external device **100**, the IMD **110** may transmit a first response to the external device **100** to inform of the completion of the device authentication or provide the information requested (**630**). If the IMD **110** provides the requested information to the external device **100** based on the first response, the operation of the IMD **110** may be terminated.

[0096] After the completion of the device authentication, the IMD **110** may confirm with the user whether to provide the requested information to the external device (**640**).

[0097] When the user makes a specific movement, a motion code which allows the IMD **110** to recognize the user's intention may be generated and transmitted to the IMD **110**. Accordingly, the IMD **110** may confirm the user's intention based on the motion code.

[0098] Then, the IMD **110** transmits a second response to the external device **100** to provide or reject the requested information based on the user's intention which has been confirmed at **640** (**650**).

[0099] FIG. **7** illustrates an example embodiment of an IMD implanted in a human body.

[0100] Referring to the example embodiment illustrated in FIG. **7**, the external device **100** may identify user's intention through a motion sensor **710** to control the IMD **700** when an external device **100** accesses the IMD **700**.

[0101] The IMD **700** may include the configuration of the IMD shown in the example embodiment illustrated in FIG. **2**.

[0102] Referring to the example embodiment illustrated in FIG. **7**, the IMD **700** may include an information store, an information store access arbitrator, a medical sensor, and a main controller and these elements may have, respectively, the same functions as those shown in the example embodiment illustrated in FIG. **2**.

[0103] In addition to the above elements, the IMD **700** may further include a communication module, a code processor/pattern store, and a notice and alarm generator **230**.

[0104] The respective elements will be described in connection with a procedure of confirming the user's intention through the motion sensor **710**.

[0105] The IMD **700** which may be implanted in a human body to collect physiological/pathological state information of a user and perform a medical procedure to normalize biological activities in the user's body and may communicate with the external device **100** (see FIG. **1**) may include the communication module for the communication with the external device **100**.

[0106] The external device **100** may be connected with the communication module of the IMD **700** and may acquire the state information of the IMD **700**, or may access the IMD **700** to acquire the physiological/pathological information of the user stored in the IMD **700**. In addition, the communication module may communicate with the motion sensor **710** and receive a motion state detected by the motion sensor **710**, and thereby recognize the user's intention.

[0107] The notice and alarm generator **230** may generate a signal to inform the user that the IMD **700** is able to receive a motion code for recognizing the user's intention. Based on the motion code, the IMD **700** may be controlled to perform a specific activity.

[0108] In this case, the motion code may be dependent on the change in position of a part of a user's body based on user's motion state which includes 1) the standstill state and moving state of the user or 2) the moving state of user's pupils. The user's motion state may be detected by the motion sensor **710**.

[0109] Although in the example embodiment illustrated in FIG. **7** the motion sensor **710** is located on user's fingers, the motion sensor **710** may be put or implanted in any part of the user's body as long as 1) the user can move the part as he/she wants and thereby generate a motion state (including a standstill state), and 2) the motion sensor **710** a) may detect the motion state resulting from the user's movement, and b) may acquire values related to changes in positions of the user's body.

[0110] In this case, the motion sensor **710** may use any method that adheres or fixes the motion is sensor **710** on a body part (fingers in the example embodiment illustrated FIG. **7**), and the motion sensor **710** may be in a wearable form (thimble-shaped in FIG. **7**).

[0111] Further, the motion sensor **710** may not only be put or implanted in the user's body but also implemented as an individual device that is located outside of the user's body as long as it is capable of detecting a motion state of the user's body. In this regard, the motion sensor **710** implemented as an individual device may only need to detect the movement of the user from the outside the user's body and transmit the detected motion state to the IMD **700** implanted inside the user's body via any method.

[0112] Moreover, the implementation of the motion sensor **710** may not be limited to the implementations described. For example, there may be a single motion sensor to detect a simple movement or there may be a plurality of motion sensors in a form which allows identification of the user's intention based on combination of patterns and three-dimensional relations of a variety of movements.

[0113] The notice and alarm generator **230** may generate a signal to notify the user that the external device **100** attempts access to the IMD **700**. In this case, the signal may be in any form including light, sound, vibration, and any kind of stimulus, as long as the user can recognize. In addition, the signal can be implemented as, for example, a clock, a terminal, or an element of an external device, based on any method as long as the user may recognize the signal.

[0114] The code processor/pattern store may receive a motion state of the user from the motion sensor **710** to control the IMD **700** which is implanted in the user's body, and may generate and store the motion code based on the motion state. In another example embodiment, the motion sensor **710** may detect motion state of the user and generate a motion code based on the detected motion state, and transmit the motion code to the IMD **700**. In this case, the code processor/pattern store for generating a motion code may be included in the motion sensor is instead of the IMD **700**.

[0115] The IMD **700** may perform a specific operation based on user's intention identified from the motion code generated as described above.

[0116] FIGS. **8**A and **8**B illustrate example embodiments of a motion sensor of an IMD.

[0117] The example embodiment illustrated in FIG. **8**A shows a basic configuration of a first motion sensor **800**. Referring to the example embodiment illustrated in FIG. **8**A, the first motion sensor **800** may include a motion measurement unit **801** and a signal transmitting unit **802**.

[0118] The motion measurement unit **801** may detect a movement of the user and measure a change in position of the user's body.

[0119] The signal transmitting unit **802** may communicate with the IMD **700** (refer to FIG. **7**) and transmit the change in position which may be measured by the motion measurement unit **801** to the IMD **700**.

[0120] The example embodiment illustrated in FIG. **8**B shows a configuration of a second motion sensor **810** that detects a motion which is a reference motion from among motions detected by a plurality of motion sensors. Referring to the example embodiment illustrated in FIG. **8**B, the second motion sensor **810** may include a reference measurement unit **811**, a signal transmitting unit **812**, and a calculation unit **813**.

[0121] The reference measurement unit **811** may be the same as the motion measurement unit **801** in terms of a function that measures a change in position of a user's body by detecting a motion of the user.

[0122] The reference measurement unit **811** of the second motion sensor **810** may be different from the motion measurement unit **801** in that it may determine a reference motion for 1) collecting a plurality of changes in positions which are measured by a plurality of motion sensors is having the same configuration as the first motion sensor **800** or 2) forming various forms of codes or patterns based on the plurality of changes in positions.

[0123] Thus, the reference measurement unit **811** may determine a motion of a specific part of the user's body as a reference motion, and the calculation unit **813** may calculate a current motion based on a relation between the reference motion determined by the reference measurement unit **811** and motions detected by a plurality of first motion sensors **800**.

[0124] The signal transmitting unit **812** may 1) communicate with the IMD **700** and the plurality of first motion sensors **800**, 2) receive the position changes measured by the first motion sensors **800**, and 3) transmit the position changes to the IMD **700**. The position changes may be transmitted through a general wireless communication method or through the body.

[0125] By the above procedures, various forms of motion codes which reflect diverse intentions of the user may be generated so that a diversity of control over the IMD **700** may be realized.

[0126] FIGS. **9**A and **9**B illustrate example embodiments for explaining motion codes generated by a plurality of motion sensors of an IMD.

[0127] As described above, the first motion sensor **800** (referring to FIG. **8**A) and the second motion sensor **810** may be applied to any part of a user's body which may make a movement, and as shown in the example embodiment illustrated in FIG. **7**, the first motion sensor **800** or the second motion sensor **810** may be worn on fingers. FIGS. **9**A and **9**B show how codes or patterns may be generated from changes in positions of fingers.

[0128] As illustrated in FIG. **9**A, a motion sensor #**0** may be adhered to or implanted in the thumb, a motion sensor #**4** may be adhered to or implanted in the index finger, a motion sensor #**3** may be adhered to or implanted in the middle finger, a motion sensor #**2** may be adhered to or implanted in the ring finger, and a motion sensor #**1** may be adhered to or implanted in the little finger.

[0129] In this case, it may be assumed that the motion sensor #**0** is applied with the second motion sensor **810** as shown in the example embodiment illustrated in FIG. **8**B, and the rest of the motion sensors are applied with the first motion sensors as shown in the example illustrated in FIG. **8**A. Under such assumption, a position change of each finger may be detected based on the movement of a hand on the basis of the thumb as a reference and the position change may be mapped as described below.

[0130] In the example embodiment illustrated in FIG. **9**A, a state in which the thumb is away from the fingers (or the thumb and the fingers spread away from each other) may be mapped to a value '0000' (0×0), a state in which only the index finger is bent toward the thumb and the rest fingers do not make significant movement may be mapped to a value '1000' (0×8), and a state in which the middle finger is bent toward the thumb and the rest fingers do not make notable movement may be mapped to a value '0100' (0×4).

[0131] In addition, the example embodiment illustrated in FIG. **9**B may be based on an assumption that motion sensors #**0**, #**4**, #**3**, #**2**, and #**1** are, respectively, adhered to or

implanted in the thumb to the little fingers in this order, and shows various motion codes generated according to finger movements.

[0132] In other cases, the same motions may be mapped to codes of different values, and the mapping may be implemented in different ways.

[0133] The example embodiments illustrated in FIGS. **9**A and **9**B may show motion codes or patterns of simple formats which are generated by the motion sensors adhered to or implanted in the five fingers and, in a similar manner, mapping may be performed with respect to other parts of the user's body by utilizing motion state generated.

[0134] FIG. **10** illustrates a flowchart of an example embodiment of a method of controlling an IMD having a motion sensor.

[0135] The method shown in FIG. **10** may be implemented by an external device **100**, an IMD **700**, and the motion sensor **710**, and will be described in relation with the example embodiment illustrated in FIG. **7**.

[0136] In the example embodiment illustrated in FIG. **10**, the IMD **700** may include a communication module, a code processor/pattern store, and a notice and alarm generator as shown in the example embodiment illustrated in FIG. **3**.

[0137] The external device **100** may request the IMD **700**, which may retain state information of itself or physiological/pathological state information of a user, to transmit the state information (**1010**) to the external device.

[0138] The IMD **700** that has received the request for the state information may confirm with the user whether to provide the state information to the external device **100** (**1020**).

[0139] The notice and alarm generator may generate a signal to notify the user that the external device **100** attempts access to the IMD **700**. In this case, the signal may be in any form including light, sound, vibration, and any kind of stimulus, as long as the user can recognize the signal.

[0140] In this case, the notice and alarm generator of the IMD **700** may draw attention or make the user recognize the access of the external device **100** by use of a signal, which is in the form of light, sound, vibration, or any kind of stimulus. In response to the signal, the user 1) may recognize an inquiry whether to provide the requested information, 2) may determine whether to provide the state information and 3) may transmit the determination result to the IMD **700** through the motion sensor **710**.

[0141] That is, the motion sensor **710** may detect a position change resulting from the motion of the user, and may transfer the detected result to the IMD **700** (**1030**). The IMD **700** may is receive the position change of a motion and may determine whether to provide the requested state information to the external device **100**.

[0142] If the user determines to provide the state information to the external device **100** (if an identified intention of the user indicates approving the providing of the requested state information), the state information retained by the IMD **700** may be transmitted to the external device **100** (**1040**). If the user rejects the request to provide the state information (if an identified intention of the user indicates rejecting the providing of the requested state information), the IMD **700** may transmit a refusal response to the external device **100** (**1040**).

[0143] FIG. **11** illustrates a method of controlling the IMD having a motion sensor.

[0144] Similar to the example embodiment illustrated in FIG. **10**, the example embodiment illustrated in FIG. **11** may be implemented by an external device **100**, an IMD **700**, and a motion sensor **710**.

[0145] However, the IMD **700** shown in the example embodiment illustrated in FIG. **11** may further include a security engine in addition to a communication module, a code processor/pattern store, and a notice and alarm generator as included in the IMD **700** shown in the example embodiment illustrated in FIG. **10**.

[0146] The method shown in the example embodiment illustrated in FIG. **10** may be implemented by the IMD including the communication module **210**, the code processor/pattern store **220**, and the notice and alarm generator **230** as shown in the example embodiment illustrated in FIG. **3**, and the method shown in the example embodiment illustrated in FIG. **11** may be implemented by the IMD including the communication module **210**, the code processor/pattern store **220**, the notice and alarm generator **230**, and the security engine **240** as shown in the example embodiment illustrated in FIG. **5**.

[0147] The external device **100** may request the IMD **700**, which may retain state information of itself or physiological/pathological state information of a user, to transmit the state information (**1101**).

[0148] Then, the IMD **700** may check whether the IMD has previously received a request to transmit the state information from the external device **100** (**1102**), and if the IMD **700** has not received a request from the same external device **100**, device authentication is carried out between the external device **100** and the IMD **700** (**1103**). If the external device **100** is not able to complete the device authentication because the external device **100** is not authorized to be provided with the state information, the IMD **700** may transmit a refusal response to the external device **100**.

[0149] In response to the request for the state information being previously received from the same external device **100** or the device authentication has been completed at **1103**, it may be determined whether the requested state information is provided according to predefined access control policies or the providing of the state information to the external device **100** is determined through the motion sensor **710** (**1104**).

[0150] The access control policies may be implemented in various ways based on the level of privacy and the level of security requested by the user for the state information retained in the IMD **700**. In the example embodiment illustrated in FIG. **11**, if the IMD **700** has received a request for the state information from the external device **100**, the access control policies may be implemented for the state information retained in the IMD **700** to be transmitted directly to the external device **100** (**1113**) 1) when the access is carried out within an available period predefined for the external device **100** (or the device authentication of the external device **100** has been completed) or 2) when the currently requested state information is the same as the previously requested state information (**1104**). The confirmation of providing of the state is information may be carried out via the motion sensor **710**.

[0151] Subsequently, to confirm a user's intention of whether to provide the requested state information through the motion sensor **710**, the IMD **700** may generate a signal for confirmation of the user (**1105**), and may request the user to confirm whether to provide the requested state information to the external device **100** (**1106**).

[0152] The user may be enabled to recognize the request for the state information from the external device **100** through the signal generated at **1105**, and makes a motion as described above. Then, the motion state may be detected by the motion sensor **710** (**1107**). In this case, the motion sensor **710** may compute the motion state or a motion code based on a stand-

still state and moving state of the user or a moving state of user's pupils (**1107**), and the motion state may allow the recognition of the user's intention for the request for the providing of the state information of the IMD **700**. The motion state may be implemented as a code or a pattern, as described above.

[0153] The computed motion state or motion code may be transmitted to the IMD **700** (**1108**). The IMD **700** may receive the user's motion state from the motion sensor **710**, and may identify the user's intention of whether to provide the requested state information to the external device **100** (**1109**).

[0154] If the user authenticates the providing of the state information (**1110**), that is, if the requested state information is determined to be provided to the external device **100**, the requested state information retained by the IMD **700** may be transmitted to the external device **100** (**1111**, **1112**, and **1113**). If the user refuses to approve the providing of the state information (**1110**), that is, if the requested state information is determined not to be provided to the external device **100**, the IMD **700** may generate a response message to refuse to provide the state information to the external device **100** (**1112**) and may transmit the generated response message to the external is device **100** (**1113**).

[0155] The above-described IMD may allow the recognition of the user's intention with respect to an access or a request for information by an external device, and may be controlled by the recognized user's intention. Hence, the recognition of the user's intention may be included as a technical element.

[0156] Accordingly, example embodiments of recognition of the user's intention, as illustrated in FIGS. **12** and **13**, may be taken into consideration. However, any other example embodiments which may recognize a user's intention falls within the scope of the teachings described herein.

[0157] FIG. **12** illustrates an example embodiment showing body parts of a user that allows the recognition of a user's intention through a motion state of the user.

[0158] Referring to the example embodiment illustrated in FIG. **12**, an implantable medical device (IMD) **1200** may have a structure to recognize the user's intention for an access or an information request from an external device **100**, and be controlled by the recognized intention.

[0159] As shown in the example illustrated in FIG. **12**, the body parts that allow the recognition of the user's intention may include a head **1210** (facial muscles, eyes, pupils, eyelids, ears, neck, and the like), shoulders **1220**, elbows **1230**, hands or wrists **1240**, a waist **1250**, knees **1260**, feet or ankles **1270** and the like.

[0160] The motion sensor illustrated in the example embodiment of FIG. **8**A or **8**B may be put or implanted in any body part to detect the motion state, thereby recognizing the user's intention. In addition, a third device which has been previously described in the example embodiment illustrated in FIG. **7** may be employed as long as the device can detect the motion state for recognizing the user's intention.

[0161] Further, the user's intention may be based on consciousness (thinking) resulting from a brain activity, and any form of directly recognizing the user's intention resulting from the brain activity falls within the scope of the teachings described herein.

[0162] FIG. **13** illustrates an example embodiment of a structure for controlling an IMD by recognizing a user's intention through the direct detection of the brain activity. Referring to the example embodiment illustrated in FIG. **13**, the IMD **1200** 1) may recognize the user's intention with respect to an access or an information request from an external device **100** using a detecting unit **1300** implemented in a user's brain or in proximity to the brain, and 2) be controlled based on the recognized intention.

[0163] The IMD **1200** 1) which may be implanted in a human body to collect physiological/pathological state information of a user or 2) which may be closely connected to the organs of the users to control the operation of the organs may have the same structure as shown in the example embodiment illustrated in FIG. **2**.

[0164] Hence, the IMD **1200** may include an info store, an info store access arbitrator, a medical sensor, and a main controller, and their functions may be substantially the same as those shown in the example embodiment illustrated in FIG. **2**.

[0165] In addition to the above primary structure, the IMD **1200** may further include a communication module, a code processor/pattern store, a notice and alarm generator, and a security engine. The code processor/pattern store of the example embodiment illustrated in FIG. **13** may be partially or entirely substituted by the detecting unit **1300** which may be implemented in the user's brain or in proximity to the brain.

[0166] The external device **100** may be connected to the communication module of the IMD **1200** 1) to acquire state information of the IMD **1200**, or 2) to access the IMD **1200** to acquire is physiological/pathological information of the user which may be stored in the IMD **1200**.

[0167] The IMD **1200** may be enabled to recognize the user's intention through the detecting unit **1300** with respect to a request of the external device **100** that accesses the IMD **1200** for various purposes.

[0168] The detecting unit **1300** may be directly or indirectly connected to the user's brain to detect movements (gestures or motions) of the user, including 1) a standstill state or moving state of the user and a movement of pupils, through an electrical reaction in a motor nerve or a sensory nerve, or to directly analyze or 2) identify the user's consciousness based on a brainwave state resulting from an electrical/chemical reaction in the user's brain. Further, the detecting unit **1300** may generate a motion code based on the detected or analyzed result to allow the IMD **1200** to reflect the user's intention with respect to the access from the external device **100**.

[0169] Thus, the IMD **1200** may receive the motion code generated by the detecting unit **1300** which directly/indirectly may recognize the user's intention resulting from the brain activity, and may provide the requested state information, may refuse to provide, or may provide any other response to the external device **100** based on the received motion code.

[0170] FIG. **14** illustrates a flowchart of an example embodiment of a method of controlling an implantable medical device (IMD) by recognizing a user's intention based on direct detection of brain activity.

[0171] The method of controlling the IMD may be performed between an external device **100**, the IMD **1200**, and a detecting unit **1300**. The method illustrated in FIG. **14** may control the IMD **1200** having the primary structure which is shown in the example embodiment illustrated in FIG. **13**.

[0172] The external device **100** may access the IMD **110**, which may retain state information of is itself or physiological/pathological state information of a user, to acquire the state information (**1410**).

[0173] The IMD **1200** may confirm the user whether to allow access of the external device **100** or to provide the requested state information. In this case, the IMD **1200** may generate a signal in the form of light, sound, vibration, or any kind of stimulus to notify the user that the external device **100** attempts access or issues a request to the IMD **1200** (**1420**).

[0174] Then, the user may recognize an inquiry whether to allow the providing of the requested state information or the access of the external device **100** through the signal, may make a decision about the provision or the state information or the access of the external device **100**, and may transmit the result to the IMD **1200** through a motion code generated by the detecting unit **1300** (**1430**).

[0175] The detecting unit **1300** may be directly or indirectly connected to the user's brain 1) to detect movements (gestures or motions) of the user, including a standstill state or moving state of the user and a movement of pupils, through an electrical reaction in a motor nerve or a sensory nerve, or 2) to directly analyze or identify the user's consciousness based on a brainwave state resulting from an electrical/chemical reaction in the user's brain. Further, the detecting unit **1300** may generate a motion code based on the detected or analyzed result to allow the IMD **1200** to reflect the user's intention with respect to the access from the external device **100**. Thus, the IMD **1200** may receive the motion code generated by the detecting unit **1300** which directly/indirectly recognizes the user's intention resulting from the brain activity, and may provide the requested state information, refuse to provide, or may provide any other response to the external device **100** according to the received motion code (**1440**). The IMD **1200** 1) may be allowed to recognize the user's intention based on the user's motion state is including a standstill state and a moving state of the user, a moving state of pupils, and a brainwave state, and 2) may determine whether to permit the access of the external device **100** according to the user's intention.

[0176] When the user confirms to provide information (in this example, in which the user only thinks of allowing the provision of information), or when the IMD **1200** provides the requested state information, the IMD **1200** may transmit the requested information to the external device **100** (**1440**). When the user refuses to provide the information (in this example embodiment, when the user thinks of refusing to provide the information), the IMD **1200** may transmit a refusal response to the external device **100** (**1440**).

[0177] Program instructions to perform a method described herein, or one or more operations thereof, may be recorded, stored, or fixed in one or more computer-readable storage media. The program instructions may be implemented by a computer. For example, the computer may cause a processor to execute the program instructions. The media may include, alone or in combination with the program instructions, data files, data structures, and the like. Examples of computer-readable media include magnetic media, such as hard disks, floppy disks, and magnetic tape; optical media such as CD ROM disks and DVDs; magneto-optical media, such as optical disks; and hardware devices that are specially configured to store and perform program instructions, such as read-only memory (ROM), random access memory (RAM), flash memory, and the like. Examples of program instructions include machine code, such as produced by a compiler, and files containing higher level code that may be executed by the computer using an interpreter. The program instructions, that is, software, may be distributed over network coupled computer systems so that the software is stored and executed in a distributed fashion. For example, the software and data may be stored by one or more computer readable recording mediums. Also, functional programs, codes, and code segments for accomplishing the example embodiments disclosed herein can be easily construed by programmers skilled in the art to which the embodiments pertain based on and using the flow diagrams and block diagrams of the figures and their corresponding descriptions as provided herein. Also, the described unit to perform an operation or a method may be hardware, software, or some combination of hardware and software. For example, the unit may be a software package running on a computer or the computer on which that software is running. A number of examples have been described above. Nevertheless, it will be understood that various modifications may be made. For example, suitable results may be achieved if the described techniques are performed in a different order and/or if components in a described system, architecture, device, or circuit are combined in a different manner and/or replaced or supplemented by other components or their equivalents.

[0178] Accordingly, other implementations are within the scope of the following claims.

What is claimed is:

1. An implantable medical device (IMD) comprising:

a medical procedure performing unit configured to perform a medical procedure inside a body of a user;

a code generating unit configured to detect a motion state of the user, and to generate a motion code that represents a user's intention based on the detected motion state; and

a control unit configured to control the medical procedure of the medical procedure performing unit based on the generated motion code.

2. The IMD of claim **1**, wherein the medical procedure performing unit collects physiological/pathological state information of the user.

3. The IMD of claim **2**, wherein the control unit determines whether to transmit the is physiological/pathological state information to an external device based on the motion code.

4. The IMD of claim **1**, wherein the code generating unit detects the motion state that includes a standstill state of the user, a moving state of the user, a moving state of user's pupils, a brainwave state of the user, or a combination thereof.

5. The IMD of claim **1**, wherein the code generating unit comprises:

a first sensor configured to set a reference for the motion state of the user; and

a second sensor configured to detect the motion state which includes the standstill state of the user, a moving state of the user, a moving state of the user's pupils, or a combination thereof.

6. The IMD of claim **5**, wherein the first sensor or the second sensor is placed outside of the user's body to detect a motion state of the user.

7. The IMD of claim **1**, wherein the code generating unit comprises a sensor configured to be worn on or implanted in a user's finger to detect the motion state of the user.

8. The IMD of claim **2**, further comprising:

an authenticating unit configured to authenticate whether the external device which communicates with the IMD is authorized to acquire the physiological/pathological state information of the user.

9. The IMD of claim **8**, wherein the code generating unit generates the motion code in response to the authenticating

unit authenticating the external device to be authorized to acquire the physiological/pathological state information.

10. The IMD of claim **2**, further comprising:

a notice and alarm generator configured to generate a signal to notify of an access of the external device in response to the external device attempting to access the IMD to communicate therewith.

11. The IMD of claim **10**, wherein the notice and alarm generator generates a recognizable signal in the form of light, sound, vibration, stimulus, or a combination thereof.

12. An implantable medical device (IMD) comprising:

an information collecting unit configured to collect physiological/pathological state information of a user; and

a provision determining unit configured to detect a motion state of the user, and to determine whether to provide the physiological/pathological state information to an external device according to a user's intention identified based on the detected motion state.

13. The IMD of claim **12**, wherein the provision determining unit comprises:

a communication module configured to transmit the physiological/pathological state information to the external device;

a detecting unit configured to detect a motion state which includes a standstill state of is the user, a moving state of the user, a moving state of user's pupils, a brainwave state of the user, or a combination thereof;

a code generating unit configured to generate a motion code that represents the user's intention for the providing of the physiological/pathological state information based on the detected motion state; and

a control unit configured to control the communication module based on the generated motion code.

14. The IMD of claim **12**, further comprising:

a notice and alarm generator configured to generate a signal to notify of an access of the external device in response to the external device attempting to access the IMD to acquire the physiological/pathological state information.

15. The IMD of claim **12**, further comprising:

an authenticating unit configured to authenticate whether the external device that communicates with the IMD is authorized to acquire the physiological/pathological state information.

16. The IMD of claim **15**, wherein the authenticating unit authenticates the external device by determining whether the external device has previously accessed or whether physiological/pathological state information to be transmitted is the same as the physiological/pathological state information requested by the external device.

17. The IMD of claim **15**, wherein the provision determining unit detects the motion state of the user in response to the external device being authorized to acquire the physiological/pathological state information.

18. The IMD of claim **13**, wherein the code generating unit compares the motion state of the user with a previously stored motion state of the user and generates a motion code corresponding to the detected motion state.

19. A method of controlling an implantable medical device (IMD) with respect to an access of an external device, the method comprising:

receiving a request for state information of the IMD or physiological/pathological state information of a user from the external device;

identifying a user's intention by detecting a motion state of the user; and

determining whether to transmit the requested state information to the external device according to the identified user's intention.

20. The method of claim **19**, wherein the identifying of the user's intention comprises detecting the motion state of the user which includes a standstill state of the user, a moving state of the user, a moving state of user's pupils, a brainwave state of the user, or a combination thereof.

21. The method of claim **20**, wherein the identifying of the user's intention comprises:

generating a motion code that represents a user's intention based on the detected motion state of the user; and

identifying the user's intention that corresponds to the generated motion code by comparing the generated motion code with a previously stored motion code.

22. The method of claim **19**, wherein the determining whether to transmit the requested state information comprises providing the state information to the external device or transmitting a refusal response to the external device according to the identified user's intention.

23. An external device for communicating with an implantable medical device (IMD), the external device comprising:

a communications unit configured to access state information stored in the IMD; and

a reception unit configured to receive the state information determined by a motion state of the user corresponding to a user's intention detected by the IMD.

24. The external device of claim **23**, wherein the user's intention includes allowing the transmission of the state information or restricting the transmission of the state information.

25. The IMD of claim **1**, wherein the user's intention includes allowing the performance of the medical procedure or restricting the performance of the medical procedure.

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